Weng, Y., & Zheng, B. (2020). A multi-methodological approach to studying time-pressure in written translation: Manipulation and measurement. *Linguistica Antverpiensia, New Series: Themes in Translation Studies*, 19, 218–236.

A multi-methodological approach to studying time-pressure in written translation: Manipulation and measurement

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Abstract

The effect of time pressure on task performance of written translation has been researched since the 1990s. However, little attention has been paid to the methodological issues of manipulating and measuring time pressure in these empirical studies. To bridge this gap, we propose a methodological framework involving diverse approaches to time-pressure manipulation and measurement. Specifically, in addition to objectively constraining the time frame for a task, we present three subjective time-pressure manipulation strategies: giving pre-task instructions about time, increasing participants' intrinsic motivation for the task, and visualizing the elapse of time. Meanwhile, a range of feasible methods of time-pressure measurement is structured from the physiological, psychological and behavioural perspectives. This includes physiological measures such as galvanic skin response, heart rate, blood pressure, pupil dilation and salivary cortisol test, psychological measures such as psychometric instruments and retrospective questionnaires, and behavioural measures such as eye movements and keystroke activities. Based on a thorough survey of existing studies and the merits borrowed from neighbouring disciplines, this article aims to strengthen and enrich the methodology of time-pressure studies and benefit future translation research on relevant topics.

Keywords: time pressure; manipulation and measurement, multi-methodological approach; Cognitive Translation Studies

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1. Introduction

The study of the ways in which time pressure (TP) affects patterns of human behaviour and task performance has been a common topic in different disciplines over decades. In the field of Cognitive Translation Studies (CTS) (see Halverson, 2010), investigating the effect of TP on translation performance and linguistic behaviours can be traced back to the late 1990s (e.g., Hönig, 1998; Jensen, 1999), a period with an abundance of insightful findings. Notably, Jensen (2000) found that TP affected the choice of coping tactics during the translation process: participants tend to "respond to time pressure by selecting coping tactics with fewer cognitive demands, such as omission and borrowing" (p. 170). Apart from the use of strategies, more studies focused on the manner in which TP affected translation performance. Interestingly, De Rooze (2003) found that nearly 20% of the students produced better translations under a tighter time constraint (10-minute) than under the more relaxed time constraint (15-minute) and more than 25% maintained the same quality under the two conditions. This finding implies that for a large proportion of translators a longer period of time does not guarantee a better translation product and that a certain degree of TP may result in an improvement in translation quality. The results of the study by Kourouni (2012) showed that although the overall translation quality for the task with a longer time frame was better than the tasks with relatively shorter time frames, the differences failed to reach a level of statistical significance. In the same vein, a trade-off effect was observed in Ghobadi et al. (2017): participants who executed the task under TP produced more translated materials but of inferior quality than the participants who completed the task without a time constraint. As a predominant situational challenge for translators in their professional work environment, TP's effect on task performance is certainly worth further investigation based on such intriguing findings. Meanwhile, the methodological issues involved in such studies deserve equal attention.

Methodologically, most of the previous studies employed a *fixed deadline* to induce TP in the experiment: they would identify an appropriate time interval from a pre-test or a pilot study and then assume that a reasonable fraction of that time interval would naturally impose TP on the participants. Below is an example taken from Jensen (2000):

> Two professional translators took part in the pilot studies and I subsequently assumed that non-professional translators, who have no training or routine in translation, would need more time than professionals. The texts averaged about 120 words in length, and 30 minutes was chosen as a time interval that would be sufficient time for both groups. Similarly, it was expected that all informants would feel pressed for time when it was reduced to 10 minutes. (p. 81)

Another method used in some studies is the *individual deadline*, which means that the deadlines applied to each participant are individualized in line with their own translating speed. An example from Hansen (2006) illustrates this:

> The students were asked to translate texts of different degrees of difficulty using Translog at home under normal working conditions. Using the log files of these translations, I could register the period of time they had used for translation of 10 lines when not using dictionaries or the Internet. Based on that information, I calculated their average translating speed. My

> pilot experiments had shown that they needed some time for orientation – which I gave them in relation to the number of lines they had to translate. (p. 73)

In most existing studies, regardless of the type of deadline applied, TP is assumed to be induced by constraining the given time frame before the TP effects on task performance were concluded. Actually, apart from this rather basic trigger of TP, supplementary manipulation strategies for TP inducement and intensification are available. But they have rarely been noticed by researchers in CTS yet. In addition, before examining the TP effects on task performance, applying valid measures to verify the successful inducement of TP is necessary. Implementing TP verification measures can ensure that the effects on task performance are authentically caused by TP, not by other confounding factors. Therefore, it is essential to consider both manipulation strategies to induce TP and measurement approaches to verify TP in the experiment. Given the importance of such methodological considerations, Bayer-Hohenwarter (2009) made a significant attempt to explore the opportunities for improving the methodology of studies investigating TP's effect on translation. She thoroughly reviewed the methods employed in major experimental translation studies on TP and summarized their methodological approaches (see Figure 1).

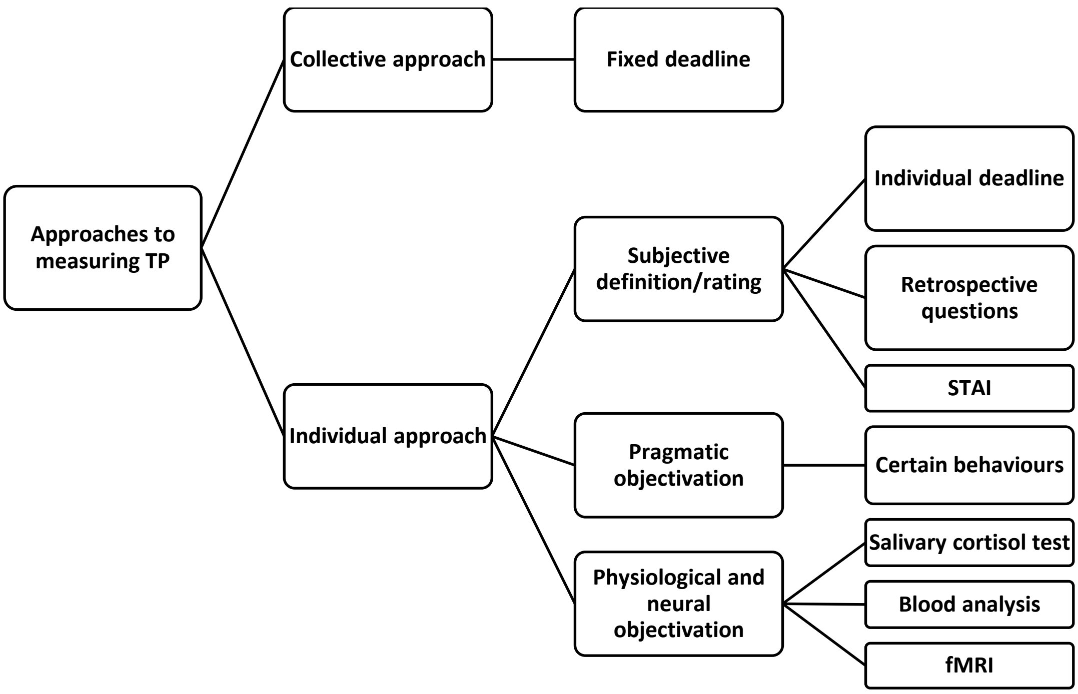

Figure 1. Approaches to measuring TP converted from Bayer-Hohenwarter (2009)

Figure 1 shows that two branches of approach to TP measurement were identified and discussed in the framework by Bayer-Hohenwarter (2009): the collective and the individual approaches. Imposing a predefined fixed deadline for all participants on the task is called a collective approach, whereas applying an individual deadline based on each participant's typing or translating speed is considered one of the *subjective definition/rating* approaches.

The subjective approach also includes retrospective questions and the State–Trait Anxiety Inventory (STAI), which is a set of self-report questionnaires measuring the participants' in-situation (State) and baseline (Trait) anxiety levels. In addition to the subjective approach, there are pragmatic and physiological objectivations within the scope of the individual approach. *Pragmatic objectivation* refers to certain behaviours that signal a stressful or a pressured state, whereas the *physiological objectivation* refers to the biological reactions to stress, which can be measured through, for example, salivary cortisol test, blood analysis, or functional magnetic resonance imaging (fMRI). Moreover, Bayer-Hohenwarter (2009) suggested that individual approaches collect more accurate data than the collective approach, whereas of all the individual approaches, physiological objectivation yields the most reliable data.

This framework offers a clear-cut categorization of the various means of TP measurement. Still, it can be further refined in several aspects. First, categorizing the fixed and individual deadlines into different approaches of TP measurement seems inappropriate because imposing a deadline on a task is a trigger to inducing TP rather than a measurement of TP. As mentioned, there are other supplementary strategies to induce TP besides controlling the actual time available. Such supplementary strategies that are applicable to translation experiments should be identified. Along with the fixed and individual deadlines, they should be categorized as TP Manipulation Strategies.

Second, Bayer-Hohenwarter (2009) proposed only a limited number of physiological objectivations of TP, with blood analysis being the best but an impractical option and fMRI being a promising option but one lacking ecological validity. When evaluating the methods used to measure cognitive load in simultaneous interpreting, Seeber (2013) pointed out that they should be assessed against four requirements: noise-resistance, non-invasiveness, temporal resolution and affordability. These considerations are also applicable to the present concerns about evaluating the methods for measuring TP in written translation. It is reasonably argued that taking blood from participants during the translation experiments or asking them to complete translation tasks while lying in an fMRI scanner is invasive and unnatural. Furthermore, employing methods such as blood analysis or fMRI is highly complex and expensive. In fact, there are numerous other physiological indicators of stress which can serve as measures of TP, such as heart rate (HR), blood pressure (BP), galvanic skin response (GSR) and pupil dilation (PD). These indicators are much more feasible, cost-efficient and ecologically suited to being applied in translation experiments. Similarly, the means of pragmatic objectivation could also be expanded to broader dimensions. With the increasing applications of eye-tracking and key-logging technologies as research methods in CTS, parameters including number and duration of fixations and pauses could provide insightful evidence as behavioural measures of TP.

Based on the previous work, a methodological framework is constructed combining both TP manipulation strategies and measurement approaches in CTS (see Figure 2). First, we take proper inducement of TP as a prerequisite for investigating the TP effects on translation task performance. Therefore, manipulating the experiment to ensure that TP is optimally induced is the first step. We propose that TP can be manipulated at a pre-task stage by applying actual time constraints (fixed or individual deadlines) and by enhancing participants' subjective perception of TP. Three such subjective manipulation strategies are identified:

- emphasizing the limited amount of time available in the instructions;
- informing the participants that their work will be evaluated to increase their intrinsic motivation; and
- presenting visual and auditory time-related feedback during the task execution process.

Meanwhile, applying valid measurement approaches to verify TP before examining its effect on task performance is also essential. Therefore, a range of TP measurement approaches is structured from the physiological, psychological and behavioural perspectives at the online and post-task stages. This framework contains more feasible physiological measures such as GSR, HR, BP, PD and the salivary cortisol test; psychological measures such as relevant psychometric instruments and retrospective questionnaires, and behavioural measures such as variations of eye movements and keystroke activities.

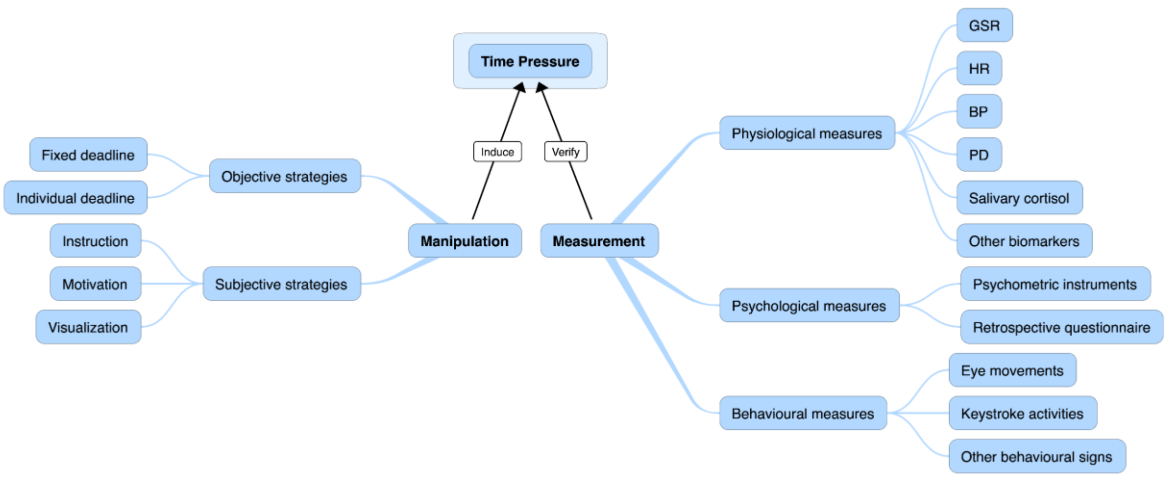

Figure 2. A methodological framework for manipulating and measuring TP in CTS

The TP manipulation strategies and measurement approaches are differentiated based on their application at different stages of an experiment. Overall, the *TP Manipulation Strategies*, that is, imposing different types of deadline and supplementary TP trigger, should be designed at the pre-task stage for the purpose of TP inducement; the *TP Measurement Approaches* should be applied during or after the task to assess and verify TP. The details of each TP manipulation strategy and measurement approach are discussed in the following sections.

2. Manipulating time pressure in an experimental setting

2.1 Rationales and mechanisms of time-pressure inducement

To investigate the effect of TP on human behaviour or task performance, researchers first need to ensure the existence of TP. This makes the experimental manipulation of TP inducement necessary. Only by properly manipulating TP can researchers be reasonably assured that the observed changes in task performance are indeed related to the variation of TP. As a form of psychological stress, TP can be considered as an interactional process, where the amount of time required is weighed against the amount of time available to execute a task (Rastegary & Landy, 1993). Yet the notion of TP involves not only the objective time constraints, but also “the feeling of time pressure, where individuals perceive the time available to them to be insufficient” (Rattat et al., 2018, p. 81). So, it is necessary to differentiate between the actual (objective) and the perceived (subjective) time availability because they all affect the degree of TP.

This distinction between the two origins of TP underlies the availability of manipulating both the objective time constraint and the subjective time perception to induce or intensify TP in an experiment. Zakay (1993) described the cognitive processes of time perception by distinguishing between the prospective and the retrospective paradigms. He pointed out that TP occurs at the prospective paradigm of time perception when participants are “aware of and occupied with the passage of time” (Zakay, 1993, p. 66). Therefore, in studies with deadlines investigating TP effects on task performance, the attentional resources are allocated to task processing and monitoring the passing of time simultaneously. Because attentional resources are limited, the more resources are devoted to monitoring the passing of time, the less attention is left for performing the task. TP can therefore be induced by constraining the time frame, increasing the task demand or intensifying the participants’ perception of TP by, for example, enhancing their awareness of time elapse.

2.2 Time-pressure manipulation strategies

2.2.1 Categorization of the strategies

Rendón-Vélez et al. (2016) provided a summary of the strategies that researchers have used to induce TP in general laboratory settings (see Figure 3). Their work shows that TP can be induced by controlling the amount of time available and the participants’ motivation. The amount of time available can be manipulated objectively (by implementing a fixed or an individual/adaptive time constraint) and subjectively (by simply giving instructions such as “you must work quickly”). Motivation can be manipulated by designing tasks that engage the participants psychologically and stimulate their performance, such as that in a gaming or competition situation, or implementing external cues such as visual/audio feedback.

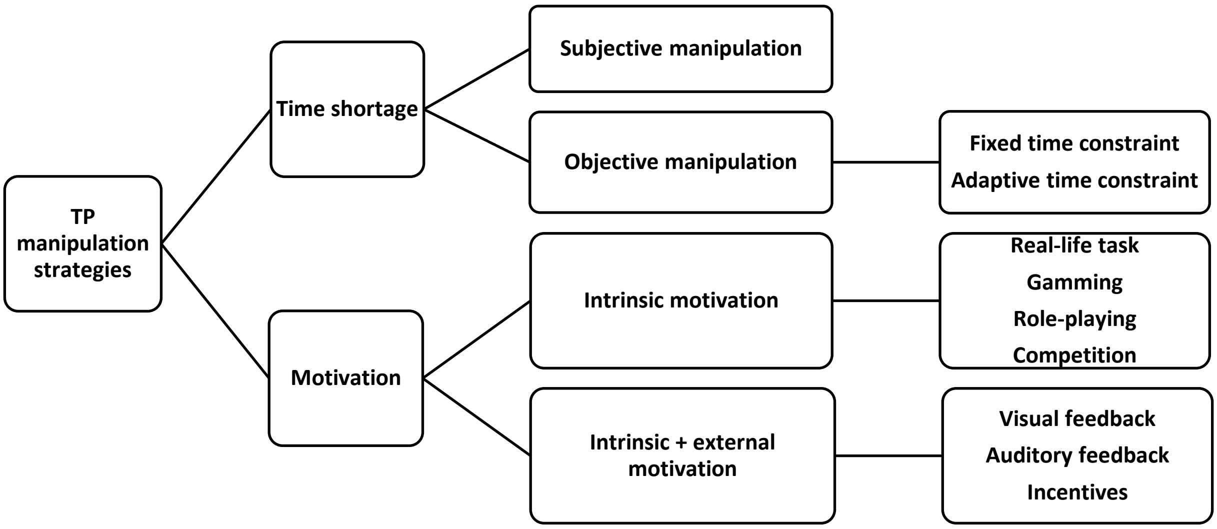

Figure 3. Categorization of time-pressure manipulation strategies (Rendón-Vélez et al., 2016)

We would like to propose a slightly different categorization of the strategies mentioned by Rendón-Vélez et al. (2016) based on the rationales of TP inducement discussed in Section 2.1. TP occurs with the imbalance between the task demand and the amount of time required: it can be induced by increasing the actual/perceived task demand, by reducing the actual/perceived time available or by improving the participants' awareness of time passing, which is also a way of increasing the perceived total task demand by its very nature. Table 1 illustrates the relationship between these dimensions and lists the corresponding strategies for TP manipulation.

Table 1. Strategies for TP manipulation

	Objective strategies	***Subjective strategies***
Time availability ↓	*Deadlines* Shorten the time available	*Instruction* Reduce the perceived time available
Task demand ↑	Increase the complexity of the actual task	*Motivation* and *visualization* Increase the perceived task demand

First, when the task complexity is kept consistent, the time frame can be shortened (i.e. to impose stressful deadlines) to induce TP; when time availability is consistent, the complexity of the task can be increased to intensify TP. Clearly, these two strategies belong to the objective manipulation of TP. Second, to reduce the perceived time availability for the participants, researchers can simply inform the participants in the pre-task *Instruction* that the time given for the task is shorter than that which is normally required. Third, one way to increase the perceived task demand for the participants is to motivate them as much as possible (e.g., providing incentives or making it a competition); the other way is to insert visual/audio feedback during the task, which can effectively improve the participants' awareness of time elapse by constantly reminding them how much time is left. The following sections illustrate in detail how to operationalize each of these aspects.

2.2.2 Objective manipulation of time pressure

As shown in Table 1, in theory, the two objective manipulation strategies are to either shorten the time frame or render the task more complex. However, increasing the complexity of a task seems to shift the focus of the study to another variable – task complexity – rather than remaining on TP. And in practice, complicating a task is not as feasible as imposing a tight deadline on a given task for the study of TP effects. Therefore, in this section we concentrate mainly on the objective strategy of imposing a deadline to induce TP. Although it seems self-evident that constraining the time frame for a task straightforwardly triggers TP, there are difficulties in establishing how much time to constrain in order to observe the effects of TP on task performance. For most behavioural studies, the time constraint is determined by registering the average amount of time taken by the participants in a pilot study or the control group and then reducing that time by a fraction and to apply that to the experiment group. Jensen (2000) applied a similar strategy in CTS.

But what should the size of this fraction be and how one justifies the chosen time frame remains a critical issue in the experimental design. Some examples of methods employed in behavioural studies may shed some light in this regard:

- In Stuhlmacher and Champagne (2000), a study investigating the effect of TP on negotiation performance, the time frame was set at half the median time required by the participants to finish the task in a pilot study;
- In Maule et al. (2000) one standard deviation below the mean time taken by control participants was chosen as a time frame for the experiment group to investigate the TP effect on a decision-making process.

An alternative way of justifying a time frame is to refer to an existing theory or the validated results of previous research in the field. For example, a study by Furlan et al. (2016) investigating TP effects on probabilistic reasoning tasks first identified the widely accepted adults' reading rate for learning, which is 100–200 words per minute, and then averaged it to 150 words per minute to calculate the time frame based on the word count of the test material in their study. Such methods of determining and justifying the time frame dedicated to inducing TP may offer some appropriate suggestions for TP manipulation for CTS.

The other type of deadline applied in CTS – namely, the individual deadline – for which the time frame is established based on each individual's own pace of working, is not as commonly used as the fixed deadline in behavioural and psychological studies. However, translation scholars (e.g., Bayer-Hohenwarter, 2009; Hansen, 2006) argue that this type of deadline is preferred in empirical translation research because it takes individual difference, the individual's *translating speed*, into account. Therefore, the TP effects would in principle be captured at a higher level of efficacy. In practice, however, individual *translating speed* is extremely difficult to measure. While it is possible to test a participant's *translating speed* for a specific text, this speed would not be representative enough to apply to all texts translated by the same person. *Translating speed* is dependent on translators' familiarity with the subject-matter of the source text (ST) and their background knowledge of it. Furthermore, both the external environment and the translators' mental and physical condition also change over time. All of these variables are contributing factors that affect *translating speed* at different stages. In this respect, an individual's *translating speed* in a pre-test cannot be assumed to be their natural and actual speed for a subsequent experimental task. Consequently, so far as inducing TP is concerned, the individual deadline may not necessarily function better than a fixed deadline.

Overall, while both fixed and individual deadlines remain available options as objective TP manipulation strategies, the focus should be placed on the extent to which the time frame is to be constrained in order to induce TP. For a translation experiment, how to determine and justify a time frame dedicated to inducing TP is highly dependent on factors such as text difficulty and the competence of the participants. Therefore, the use of concepts such as *translating speed* should be considered with great care.

2.2.3 Subjective manipulation of time pressure

As mentioned in Table 1, three supplementary strategies – instruction, motivation and visualization – that could help elicit TP by decreasing the perceived time availability or by increasing the perceived task demand are identified. The details of the three strategies are presented below.

Instruction refers to manipulating pre-task instructions that are deliberately designed to make the participants feel pressured by decreasing the perceived time available. An extreme instance of such manipulation is presented in De Dreu (2003), a study that focused on the effect of TP on negotiation performance, in which *instruction* turned out a successful manipulation:

> Participants in both experiments were given the same amount of time for the negotiation, regardless of experimental conditions. However, in the high time pressure conditions, participants were led to believe that this amount of time was relatively tight, while those in the low time pressure conditions were led to believe that this same amount of time was more than enough to reach agreement. (p. 282)

In a translation experiment focusing on TP, different deadlines will most likely be employed as an objective manipulation strategy to induce TP. If, in addition, the researcher applies the subjective strategy of *instruction* to intensify TP, it should be designed to make the participants aware that the time available to complete the task is less than is normally required. This could possibly reduce the perceived time available to the participants to complete the task.

Motivation refers to the strategy that can stimulate the participants to be more psychologically engaged in a task, which can consequently increase the perceived task demand within a certain time frame. Examples in behavioural studies involving this strategy for TP manipulation are Young et al. (2012) and Brown and Miller (2000), both of which informed the participants that their rewards (money and a raffle prize) would depend on the quality of their task performance (i.e. decision-making). In a translation experiment, for instance, informing the participants that their translation product will be assessed or providing different levels of reward based on the quality of their translation product will possibly increase their level of engagement, and in that way the intrinsic task demand could be increased.

Visualization refers to external visual feedback, namely, the numeric displays of time or progress bars that visually represent the amount of time that has elapsed. The underlying mechanism, as mentioned earlier, is that attempting to monitor the passing of time consumes the limited attentional resources and increases the total task demand. This strategy is well illustrated in Maule et al. (2000) and Furlan et al. (2016). In their studies they displayed a countdown that was visible to the participants, reminding them of the time left for the decision-making or problem-solving tasks. In a translation experiment, with the passing of time being displayed by a clock or a progress bar, the participants would intuitively pay more attention to monitoring the passing of time and TP would be induced more prominently.

In summary, the means of TP inducement by experimental manipulation can be expanded from the mere imposition of time constraints to strategies that can subjectively enhance an individual's perception of TP. The objective strategies (fixed and individual deadlines) and the subjective strategies (instruction, motivation and visualization) can be applied either independently or collectively in an experiment. In principle, applying the subjective strategies supplementary to one of the objective strategies could optimally induce TP in the experiment.

3. Measuring time pressure in an experimental setting

As previously mentioned, the purpose of applying TP measurement methods is to verify the existence of TP and to ensure that the changes in task performance are authentically attributed to TP, not to other confounding factors. TP is essentially a form of stress, so the measurement approaches of TP are identified based mainly on the physiological, psychological and behavioural responses to stress. Hans Selye (1976), the "Father of Stress", defined stress as "a state manifested by a specific syndrome which consists of all the non-specifically induced changes within the biological system" (p. 64). This definition implies a biological approach to studying stress. The biological consequences of stress include elevated BP, HR, cortisol levels, impaired cognitive function and altered metabolism (McEwen, 2007). Such biomarkers can therefore serve as TP measures. In addition, self-report questionnaires and psychometric instruments are a straightforward and commonly used approach to acquiring individuals' subjective feelings about TP. Behavioural signals, reflected by parameters such as fixation in eye movements and pauses in keystroke logging activities, can also provide additional evidence of TP in the context of translation experiments. Besides, in order to produce reliable results, a multi-method approach triangulating different types of data is recommended.

3.1 Physiological measures

As a type of stress, TP could lead to a range of physiological responses. Bayer-Hohenwarter (2009) argued that measuring such physiological processes triggered by TP exposure yields more reliable results than other TP measurement approaches. Generally, the physiological responses to stress span the hypothalamic–pituitary–adrenal axis effects (including the adrenocorticotropic hormone, cortisol, vasopressin and dehydro-epiandrosterone), the immune system effects, the sympathetic-adrenal-medullary system effects, the cardiovascular effects and the brain–gut axis effects (Allen et al., 2014). The working mechanisms of all such complex biological processes are beyond the scope of this article, especially when they have already been used as valid and standardized methods for assessing acute stress, as in the case of TP. Although assessing most of the stress-related biomarkers still remains relatively invasive – requiring, for example, the taking of blood samples from the individual – some of the other stress indicators have become easier to assess over time (Slavich et al., 2019). For instance, portable research-oriented smartwatches can continuously and accurately monitor HR, GSR and skin temperature. Such technological innovations open up valuable channels for studies requiring high ecological validity in human experimentation. Therefore, it is necessary to explore options that could be applied more feasibly in the setting of a translation experiment. The focus of this discussion on CTS will be measures such as HR, BP and GSR associated with the sympathetic and cardiovascular consequences of TP, which are relatively accessible and non-invasive in practice.

In addition, PD and (salivary) cortisol remain alternatives as physiological measures of TP. There is evidence that PD correlates with the secretion of norepinephrine from the *locus coeruleus*, which regulates arousal (such as stress) and autonomic function (Aston-Jones & Cohen, 2005). Cortisol as the main stress hormone in our body, is "putatively the most frequently investigated stress biomarker because cortisol is linked with many physiologic processes" (Shirtcliff et al., 2015, p. 505). PD and the level of salivary cortisol have been used extensively in a variety of studies as validated and reliable indicators of stress. Given the wide application of eye-tracking technology in CTS and the "non-invasiveness and laboratory independence of sampling" of salivary cortisol assessment (Kirschbaum & Hellhammer, 1994, p. 313), these two measures are recommended and included in the physiological measurements of TP in our methodological framework.

In a general laboratory-based translation experiment, researchers are always attempting to create the most natural scenario that translators may experience in their workplace. To this end, wearing a smartwatch during an experiment to record the biomarkers could minimize the interruption or influence from external devices. Some smartwatches have already come with a GSR sensor and a photoplethysmogram (PPG) sensor through which the GSR signals and cardiovascular indices such as blood volume pulse (BVP), HR and heart rate variability (HRV) can be detected and recorded continuously. Similarly, PD data can easily be obtained with an eye tracker during the experiment. In contrast, BP and salivary cortisol can be measured only at certain points in time, normally at the beginning and the end of a task. Table 2 summarizes the major biomarkers of stress that can feasibly be measured with current technologies.

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Table 2. Summary of biomarkers that are applicable to translation experiments

Biomarkers	*Can be measured continuously during a task*	*Devices*
HR/BVP/HRV	✓	Smartwatch, PPG sensor
BP	✗	BP monitor
GSR	✓	Smartwatch, GSR sensor
PD	✓	Eye tracker
Salivary cortisol	✗	Salivary cortisol test devices

The application of physiological TP measurements is still rare in written translation studies. To the best of our knowledge, only one recent study by Baghi and Khoshsaligheh (2019), which investigated stress (not TP in particular) in written and sight translation, involved HR and BP as physiological measures. They found that sight translation is indeed a more stressful activity compared to written translation, based on the results of these measurements. In interpreting studies, however, researchers started to employ physiological measures to assess stress from the 1990s. For example, Klonowicz (1994) used HR and BP to examine the way in which the effort of an interpreter changes during the working day and the parameters showed a pronounced elevation under working conditions. Moser-Mercer et al. (1998) used a salivary cortisol test and immunoglobulin concentrations to investigate the influence of prolonged working periods on the quality of an interpreter's output. In a later study, Moser-Mercer (2003, 2005) used the salivary cortisol test again, in combination with the STAI, to measure the stress level the participants experienced during remote interpreting.

Another important project on stress in interpreting studies was conducted by the research committee of the International Association of Conference Interpreters (AIIC) and there a series of physiological measures of stress (BP, HR and salivary cortisol) were involved. They demonstrated that being "on-mike" results in interpreters' experiencing the highest stress levels (AIIC, 2002). Elsewhere, Kurz (2002, 2003) used parameters of pulse rate and skin conductance (SC) level to measure and compare the stress levels between novices and expert interpreters during simultaneous interpreting. A more recent pilot study conducted by Korpal (2016) using HR and BP as physiological indicators of stress examined whether a speaker's rate of delivery influenced the level of stress experienced by interpreting trainees in a simultaneous interpreting task. Methodologically, the extensive application of physiological measures of stress in such interpreting studies undoubtedly throws light on written translation research in terms of TP measurement.

3.2 Psychological measures

One of the most commonly used and effective approaches for assessing TP levels is to administer self-report psychometric instruments. As the emotional state of anxiety is "usually regarded as a product of stress" (Dobson, 1982, p. 9), measuring how anxious an individual is in a certain situation can reflect their TP level at that moment. This legitimizes the measurement of anxiety as a psychological measure of TP. One of the most widely used psychometric instruments for anxiety measurement is the State–Trait Anxiety Inventory developed by Spielberger (1972). This instrument comprises two components, namely, the

State Anxiety Scale, which evaluates the anxiety level in the face of a threatening event, and the Trait Anxiety Scale, which measures the anxiety baseline of a given person. By involving the baseline anxiety level in the analysis, this instrument can take individual differences into account. The two scales can also be administered separately to fulfil the specific purposes of different studies.

Other psychometric instruments have also been applied in some interpreting studies adapted for different research purposes: Korpal and Jasielska (2018) employed the Positive and Negative Affect Schedule (PANAS) developed by Watson et al. (1988) to measure participants' empathy during simultaneous interpreting, while Chiang (2010) measured interpreting students' anxiety level in the interpreting class using the Foreign Language Classroom Anxiety Scale (FLCAS) (Horwitz et al., 1986). In written translation studies, however, psychometric instruments have rarely been employed in investigations on TP or stress.

In addition to the psychometric instruments measuring anxiety level, the method of retrospective questionnaire or interview is an efficient alternative for acquiring the participants' psychological experience of TP. As indicated by Minkel and Phillips (2015), measuring the subjective responses to probes into emotion is essential for validating that the chosen stimuli work as intended, because the core feature of an emotion is the participant's subjective feeling associated with it and there is no substitute for asking participants to report their own subjective experiences. TP as a form of stress shares a similar core feature as an emotion, and therefore subjective reporting counts as a significant measurement method. The most straightforward way of obtaining such data is to ask the participants to score on a Likert scale in response to questions such as "To what extent do you feel time-pressed during the task?" In CTS, similar questionnaires have been applied in a few studies for the purpose of TP verification; these include Hansen (2002a, 2002b) and Kourouni (2012).

On the other hand, the methods of self-report psychometric instruments, and the specially designed questionnaires, are retrospective in nature. They are prone to be affected by "cognitive bias and social desirability that can influence the veracity, reliability, and validity of the resulting scores" (Slavich et al., 2019, p. 409). It is, therefore, advised that such subjective data should be better triangulated with more objective data, such as those from the physiological measurements.

3.3 Behavioural measures

Bayer-Hohenwarter (2009) conceived of pragmatic objectivation as behavioural signs such as reducing or omitting information that appeared in Hansen's (2002a, 2002b) study and the observation of certain body language signalling distress in De Rooze's (2003) study. These pragmatic indicators account for only a small number of the behavioural indicators of TP. The scope of the pragmatic objectivation could be expanded further. In recent years, methods such as eye-tracking and key-logging have been applied increasingly in CTS to enquire into the cognitive processes that occur during task execution. A common assumption is that cognitive effort can, to a certain degree, be researched through the observation of the behaviours such as eye movements and keystroke activities. Also, research has shown that acute psychological stress impairs the higher-order cognitive functions such as working memory (Qin et al., 2009). As a result, the influence of TP on the cognitive functions during the translation process could be observable. It is reasonable to assume that TP could give rise to behavioural changes in eye movements and keystrokes owing to its influence on the cognitive process. Empirically, it has been found that exposure to severe TP can contribute to cognitive difficulty affecting eye-movement patterns, fixation duration and pupil dilation (Henckens et al., 2009; Wang et al., 2010). In this regard, eye movement and keystroke parameters could possibly provide evidence of TP levels in written translation experiments.

Unlike the psychological and physiological measurements, these behavioural measures may not accurately show TP levels directly. They can, however, be indicative of a time-pressured state by comparing data from two or more contrastive conditions, that is, high- vs low-pressure conditions. In CTS, many of the existing studies on TP have involved behavioural parameters, that is, examining the TP effect on eye movements or keystroke activities. Although most of them have not explicitly studied those behavioural effects from the angle of TP measurement, many of their results actually supplied evidence for the usability of the eye- and key-related parameters as behavioural measures for TP. For instance, taking pauses – one parameter from the keystroke-logging data – as signals of problem-solving activities, Jensen and Jakobsen (2000) found that when less time is given, there is a decrease in problem-solving activities in the revision phase only. This result suggests that the number of pauses during the revision phase of translation could possibly be taken as an indicator of TP. In addition, Alves et al. (2009) found that TP reduced the number of *revision pauses* in both the drafting and the revision phases, which provides another promising indicator of TP in written translation. Another example is that in Sharmin et al. (2008), where TP was found to be affecting mainly fixations on the source text (ST) – under TP, the average duration of fixation decreased significantly on the ST screen. Accordingly, this finding indicates that the average fixation duration on the ST could potentially be taken as an indicator of TP. Based on all these findings and results of the previous studies, the behavioural parameters – namely, pauses and fixations – could be considered as complementary measures of TP in written translation studies.

4. Discussion

This article has looked critically at the previous work done on TP manipulation and measurement approaches in CTS and identifies some methodological issues regarding this topic. First, in screening the major studies investigating the effect of TP on translation product and process, we found that almost all of them employed the primary TP manipulation strategy only. That is, they employed constraining the time frame to induce TP; no other studies have been found to apply any additional strategies to manipulate TP in their experiments. Although imposing a tight deadline on a task is usually taken as the most efficient way to induce TP in most experimental settings, we identified three additional options – namely, instruction, motivation and visualization – that can induce and further intensify the feeling of TP in the participants. Accordingly, we intend to diversify the methods and improve the experimental manipulation for future studies in CTS.

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Second, only a few of the existing studies implement some measures to verify TP before examining the TP's effect on task performance. Examples in CTS that explicitly apply TP verification measures are the study by De Rooze (2003), which recognized the participants' body language of distress, Hansen's (2002a, 2002b) series of experiments, which asked the participants about their feelings of TP retrospectively and identified the information omission and reduction behaviours with keystroke data, and the study by Kourouni (2012), which measured the subjective perception of TP by means of retrospective questionnaires. Most of the other studies investigating similar topics in CTS, however, did not explicitly verify TP before concluding the effects of TP on task performance. Clearly, more reliable and accurate means of TP measurement could be deployed, especially when many more advanced technologies have been developed to offer diverse options in recent years. TP measurements such as many of the validated biomarkers of stress could feasibly be applied to translation experimentation without crippling its ecological validity. More importantly, by illuminating different types of TP measurement approach that are applicable to written translation experiments, triangulating different types of data could be easier for researchers in the future.

While the present work has attempted to outline a systematic methodological framework for investigating TP in the area of translation, more work can be done in the future. The strategies and approaches involved in the proposed framework are certainly not a complete picture covering every aspect of the issue. With the development of new technologies and continuous exploration of uncharted fields, the framework can definitely be enriched by more cutting-edge techniques and methods. Furthermore, not all of the strategies and methods proposed in the present article have been empirically tested in written translation experiments – many of them have been applied only to behavioural or interpreting studies. Therefore, future research is expected to offer empirical evidence of their usability in written translation experiments.

5. Conclusion

This article has constructed a methodological framework for manipulating and measuring TP by proposing a set of strategies and methods that could be applied to written translation experiments. It set out to diversify the methodology and improve the methodological validity of studies investigating the issue of TP in written translation. We explored the relevance of theoretical and methodological considerations drawn from neighbouring disciplines that have not been previously noticed in CTS. Therefore, the taxonomical work of the methodology has been initiated in order to standardize experimental design specifically for TP studies. We consider the underlying mechanisms of TP inducement and the various approaches of TP measurement to be essential components of a study attempting to reveal the TP effects on task performance. Therefore, with the assorted strategies and methods here presented, this work might benefit future research on relevant topics in CTS.

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